Report to the State of Michigan

Enhancing safety and reducing potential impacts at Line 5 water crossings

June 30, 2018

ENBRIDGE®
Life Takes Energy™

Table of Contents

Executive Summary 1
- The Purpose of This Report 1
- Summary of Key Conclusions 2

How We Prepared This Report 3
- Likelihood Mitigation Programs 4
- Consequence Mitigation Programs 4

Enbridge's Line 5 in Michigan 5

Summary of Regulatory Requirements 6

Overview of Enbridge's Existing Mitigation Programs 7
- Mitigation Programs Focused on Likelihood (Leak Prevention) 7
  - Pipeline Integrity 7
  - Geohazard Management Program 9
  - Damage Prevention Program 10
- Mitigation Programs Focused on Consequence Reduction 11
  - Leak Detection Program 11
  - Isolation Valve Placement 12
  - Line 5 Isolation Valve Placement 14
  - Line 5 Emergency Response Plan 15
  - Environmental Management 15

Line 5 Water Crossings Consequence Evaluation and Prioritization 16
- State Technical Team Consequence Evaluation and Prioritization 16
- Additional Prioritization Based on Enbridge's Geohazard Program 17
- Summary of Prioritized Crossings 17

Assessment of Mitigation Measurers 18
- Action Items Focused on Likelihood (Leak Prevention) 18
  - Mainline Pipeline Integrity 18
  - Geohazard Management 18
  - Damage Prevention 20
- Consequence-reduction Action Items 20
  - Leak Detection 20
  - Isolation Valve Placement 20
  - Emergency Response (ER) 20
  - Environmental Management 21

Action Plan **23**

Actions to Be Implemented by Enbridge 23

Actions to Be Implemented Jointly by the State Technical Team and Enbridge 24

Appendices **25**

Appendix A: Summary of Prioritized Water Crossings and Groupings 25

Appendix B: Summary of Proposed Baseline Environmental Studies per Grouping (Rare Wetland Communities) 32

Appendix C: Abbreviations, Acronyms and Definitions 34

Executive Summary

The Purpose of This Report

On November 27, 2017, the State of Michigan and Enbridge signed a wide-ranging agreement (the Agreement) setting out a plan to improve coordination between Enbridge and the State for the operation and maintenance of the Line 5 pipeline located in Michigan, while also providing enhanced transparency to the citizens of Michigan.

In Section G of the Agreement, Enbridge committed to working with State representatives, referred to herein as "the State Technical Team", to identify and evaluate water crossings by Line 5, other than the Straits of Mackinac (the Straits), and to assessing measures to minimize the likelihood and/or consequences of a release at each water crossing location. (Line 5 crossing the Straits is the subject of two separate Enbridge reports to the State of Michigan—*Alternatives for replacing Enbridge's dual Line 5 pipelines crossing the Straits of Mackinac*; and *Mitigating potential vessel anchor strike to Line 5 at the Straits of Mackinac*. Both reports are available on enbridge.com.)

Enbridge also agreed to prepare and submit to the State no later than June 30, 2018, this Report on plans that:

1. Prioritize water crossings jointly identified by Enbridge and the State Technical Team.
2. Specify measures to minimize the likelihood and/or consequences of a release from Line 5 into the prioritized water crossings.
3. Provide a schedule for implementing the measures following Enbridge's receipt of all necessary authorizations and approvals.

The Agreement recognizes that Enbridge's 30-inch-diameter Line 5 liquids pipeline crosses important natural resources connected to the waterbodies and wetlands within the State in many areas beyond the Straits. These ecosystems are of vital significance to the State of Michigan and its residents, Native American tribes, public water supplies and regional economies.

This Report summarizes the conclusions reached through Enbridge's and the State Technical Team's collaborative process to:

- Identify and assess all Line 5 water crossings in Michigan.
- Prioritize water crossings identified with higher potential consequence due to potential of loss of containment of the pipeline.
- Assess the effectiveness of current mitigation programs to prevent and minimize consequences in the event of a pipeline leak.
- Identify proposed mitigation measures to further reduce risk.

The work focused on a thorough review and discussion, including both prevention and consequence mitigation processes.

Summary of Key Conclusions

- To prepare this Report, Enbridge and the State executed a collaborative and transparent process to identify and evaluate water crossings and assess measures to minimize risks of a release at each water crossing.
- A team of subject-matter experts representing both Enbridge and the State developed an overall plan to achieve the objectives of Section G of the Agreement.
- Enbridge maintains established mitigation programs that are designed to meet or exceed regulatory requirements and achieve quantified safety targets to ensure continued safe pipeline operation.
- Since the release of crude oil in 2010 on Enbridge's Line 6B near Marshall, Michigan, and Line 6A in Romeoville, Illinois, Enbridge has implemented substantial improvements to its previously existing mitigation programs.
- As established in the plan for this water-crossings initiative, a detailed assessment was completed to identify priority consequence areas based on local State of Michigan environment and population-based sensitivities.
- As part of this process, the State Technical Team identified nearly 400 sites where Line 5 crosses a waterbody in Michigan. To facilitate a more in-depth assessment of priority water crossings, the State Technical Team developed a consequence model to develop a relative ranking of all crossings.
- To identify additional potential prioritized water crossings, Enbridge reviewed the water crossings included in its existing Geohazard Management Program to compare them against the result of the State Technical Team's prioritization.
- Based on Enbridge's and the State Technical Team's review, a total of 74 water crossings were prioritized. These included 67 water-crossing sites identified by the State Technical Team consequence prioritization, and an additional seven sites identified by Enbridge's geohazard program review.
- Once the prioritization process was completed, the 74 crossings were reviewed collectively by Enbridge and the State Technical Team to establish boundaries around general regions of highest consequence. These areas were termed "groupings". A total of 11 groupings were established through this process.
- Enbridge then conducted a detailed review of the application of its existing mitigation programs for each individual prioritized crossing, as well as for the areas delineated into groupings. Out of that review, proposed additional actions to further reduce risk to Line 5 water crossing were identified, including:
  - Actions focused on likelihood (leak prevention), with a focus on pipeline integrity, geohazard management and damage prevention.
  - Actions focused on consequence reduction, with a focus on emergency response and environmental management.
- An action plan for completing the proposed additional actions was then agreed between Enbridge and the State Technical Team. The plan includes proposed timelines for completion of the agreed actions.

How We Prepared This Report

Enbridge and the State Technical Team executed a collaborative and transparent process to identify and evaluate water crossings and assess measures to minimize risks of a release at each water crossing.

First, a team of subject-matter experts (SMEs) representing both Enbridge and the State was formed to ensure the appropriate level of expertise was dedicated to the process in order to achieve meaningful results.

Then, in early 2018, the team developed an overall plan to achieve the objectives of Section G of the Agreement.

The plan has four phases:

1. **Development:** The SMEs reached a common understanding of the existing water crossings. A key element of this phase was sharing of information, with Enbridge presenting an overview of current prevention- and consequence-reduction programs, and the State Technical Team presenting assessment results summarizing priority-consequence areas, consequences of releases and proposed prioritization methodology. The outcome of this phase was the establishment of criteria for prioritizing water crossings and establishing a baseline understanding of Enbridge's existing mitigation programs.
2. **Planning Phase:** The SMEs jointly reviewed all Line 5 water crossings with GIS software to prioritize areas for further assessment, with Enbridge and the State Technical Team developing and presenting more detailed information to facilitate informed discussion and prioritization. The outcome of this phase was a finalized prioritization of water crossings that required additional detailed assessment.
3. **Detailed Assessment:** The SMEs conducted additional assessments of prioritized programs and water-crossing locations to identify potential actions and develop high-level agreement on actions and implementation strategies. The outcome of this phase was a list of actions identified by both Enbridge and the State Technical Team intended to further mitigate risk to water bodies and ecosystems in Michigan.
4. **Review and Approval:** This final phase included the development and documentation of proposed plans between Enbridge and the State Technical Team.

Enbridge maintains established mitigation programs that are designed to meet or exceed regulatory requirements and achieve quantified safety targets to ensure continued safe pipeline operation. Therefore, throughout this process it was considered important to examine Enbridge's existing prevention programs as well as its consequence-mitigation programs, all of which are designed to minimize risk associated with the potential of a pipeline leak.

In early discussions with the State Technical Team, Enbridge provided details about its current mitigation measures, including: what they are designed to accomplish; improvements achieved in recent years; relevant regulatory requirements; Enbridge's industry leadership position; stakeholder communications and engagements; and overall performance. The following current Enbridge programs were reviewed and discussed in depth with the State Technical Team:

Likelihood Mitigation Programs

- Pipeline integrity
- Geohazard management
- Damage prevention

Consequence Mitigation Programs

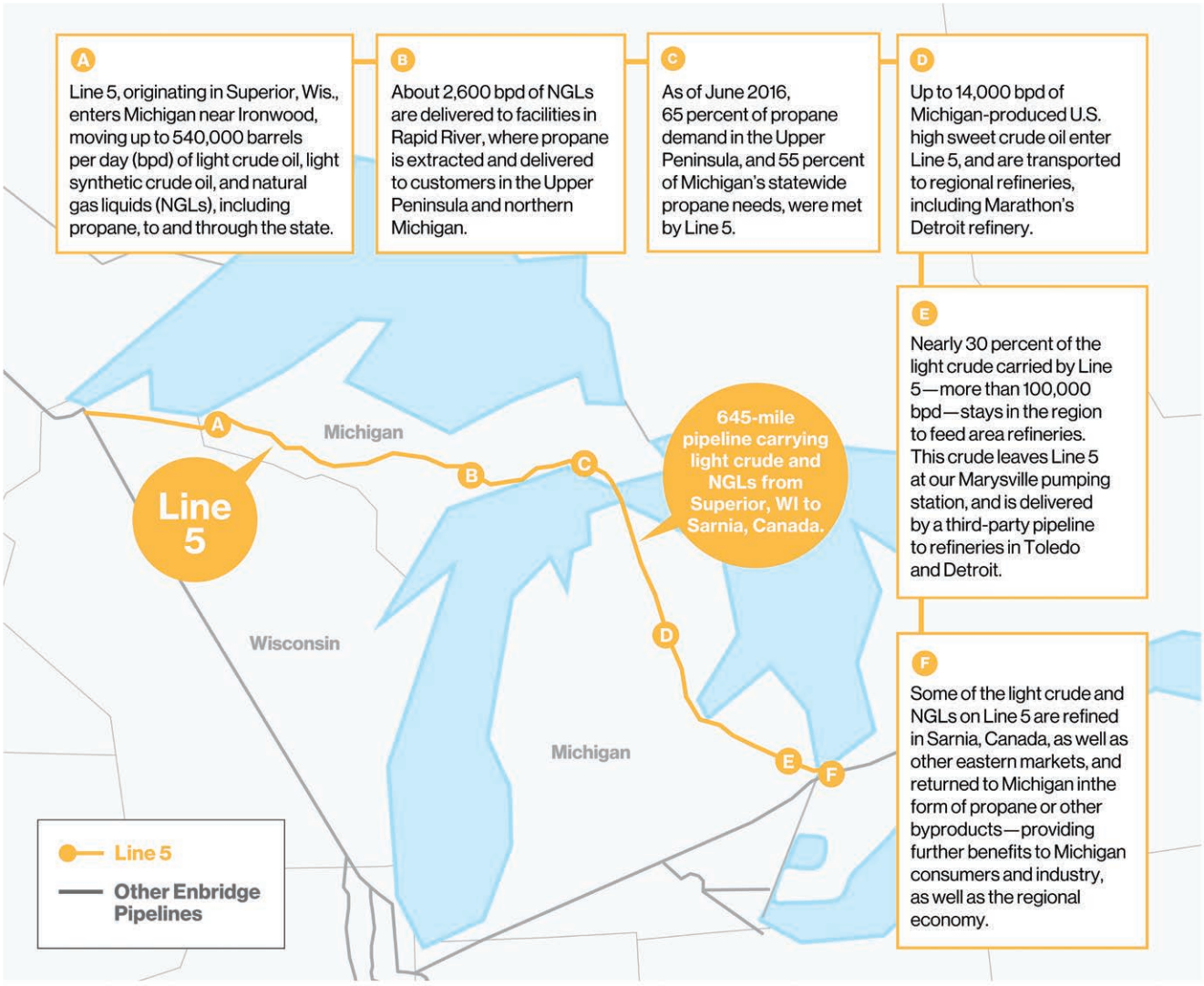
- Leak detection
- Valve placement program
- Emergency response
- Environmental management

Similarly, team discussions provided an opportunity for the State Technical Team to outline its priorities in identifying areas of greatest consequence, including: wildlife and fish habitat; species at risk; and human population factors such as drinking water and land use.

The understanding reached through all of these discussions supported the working team of subject-matter experts from both Enbridge and the State Technical Team to accomplish the four-phase plan summarized above.

Enbridge's Line 5 in Michigan

Enbridge's Line 5 is a 645-mile, 30-inch-diameter pipeline that travels through Michigan's Upper and Lower Peninsulas, originating in Superior, Wisconsin, and terminating in Sarnia, Ontario, Canada.



Quick facts on Line 5

- Enbridge's Line 5 and Line 78 are critical conduits for refineries in the region, supplying the PBF Energy (Toledo), BP (Toledo) and Marathon (Detroit) refineries with crude oil. This essential feedstock is turned into gas, diesel, jet fuel, and other refined products
- Line 5 helps to ensure a stable, secure supply of North American light crude, keeping prices down at the pump
- To date, Line 5 has carried about 80 million barrels of Michigan based light crude to market
- Line 5 does not carry, and has never carried, heavy crude

For more information on today's Line 5, please see the Enbridge brochure *The Straits of Mackinac crossing and Line 5*. (https://www.enbridge.com/~/media/Enb/Documents/Brochures/Brochure_Line5.pdf) available at enbridge.com

Summary of Regulatory Requirements

Onshore liquids pipelines are regulated by the Pipeline and Hazardous Materials Safety Administration (PHMSA), specifically through the Code of Federal Regulations, 49 CFR195 Transportation of Hazardous Liquids by Pipeline (CFR). CFR prescribes measures Enbridge is required to comply with to ensure safe operations of the Line 5 pipeline, with particular focus on high-consequence areas (HCAs). CFR provides the criteria to which definition of HCA locations is required. PHMSA verifies compliance with regular audits of Enbridge's processes and documentation.

Enbridge's operating philosophy remains focused on meeting and exceeding regulatory requirements. While Enbridge adheres to the HCA requirements of CFR, Enbridge further applies robust mitigation programs at all locations along its pipeline system. Since 2010, Enbridge has been under continual scrutiny and audit, and continues to demonstrate robust and effective management systems focused on safety and continuous improvement, while continuing to improve safety performance. Currently, Enbridge is subject to the requirements of the Consent Decree entered into with the U.S. federal government. The Consent Decree was established following the 2010 Line 6B and 6A releases, and is applicable to the Enbridge Lakehead Pipeline System, including Line 5. (For more information about the Consent Decree, please see *Overview of Enbridge's Existing Mitigation Programs*.)

The requirements included in the Consent Decree were established based on the risk mitigation programs Enbridge has continued to develop since 2010 and holds Enbridge accountable to maintain those implemented improvements to ensure improved safety performance of the pipeline system.

Further to meeting and exceeding federal regulations, this initiative offers an opportunity for Enbridge to collaborate with the State to augment existing programs with additional risk-mitigation measures and action items designed to focus on more localized priorities, in addition to HCA requirements set forth in CFR.

Overview of Enbridge's Existing Mitigation Programs

The following sections provide an overview of Enbridge's existing mitigation programs that were reviewed as part of this Line 5 water-crossings initiative. As described in *How We Prepared This Report*, presentation of these programs provided a basis of understanding of mitigation programs currently applied to the entire Line 5 pipeline. These programs formed the basis for discussions to identify opportunities to augment Enbridge's established programs to support the State Technical Team consequence priorities.

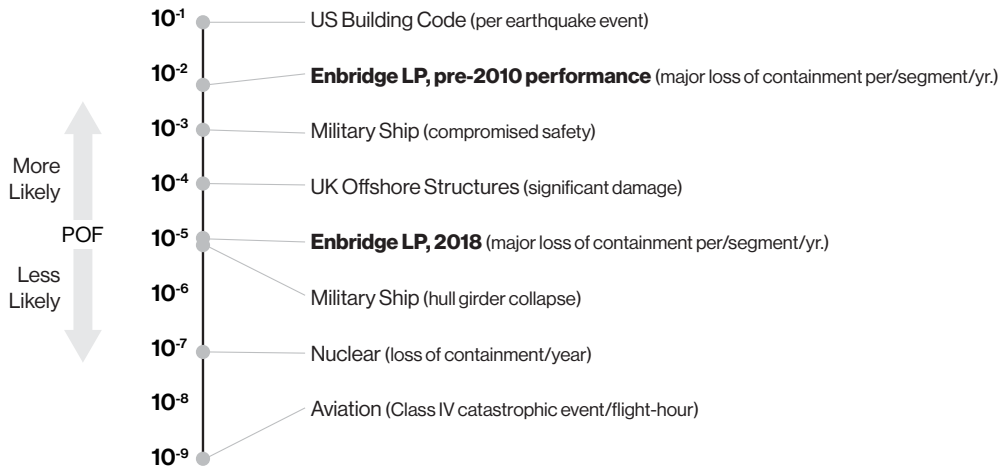
Mitigation Programs Focused on Likelihood (Leak Prevention)

Pipeline Integrity

Since 2010, Enbridge has significantly improved its Integrity Management Program, including pioneering development and application of reliability engineering science. Reliability engineering has provided a means to measure, or quantify, the level of safety achieved on each segment of pipeline and measure performance against an established safety target. Enbridge's safety target for its Mainline pipeline system*, including Line 5, is based on maintaining a probability of failure (POF) of 10^{-5} or less for major loss of containment per pipeline segment per year.

Another way to state this POF is that the likelihood of a failure on a segment of Line 5 is one in 100,000. For further perspective, this level of safety can be compared against safety targets established in some of the most safety conscious industries, as shown in *Figure 1*.

Figure 1: Comparison of established industry safety targets.



* Enbridge operates the world's longest and most complex crude oil and liquids transportation system, which moves approximately 65 percent of all U.S.-bound Canadian exports. Enbridge's Mainline System has an operating capacity of 2.85 million barrels per day and delivers western Canadian crude to eastern Canada, U.S. Midwest and Gulf Coast markets.

Enbridge maintains a state-of-the-art pipeline integrity program designed to prevent pipeline releases. The program is engineered to implement a predictive-maintenance approach to ensure continued safe pipeline operation. As part of the Integrity Management Program, Enbridge conducts an engineering assessment called a Safety Case on each segment of pipeline in the Mainline System to "prove the safety". The Safety Case evaluates the performance of the overall integrity program for each pipeline segment to confirm all threats have been identified, the appropriate management plans and technologies are being applied to mitigate those threats, and that a reliability analysis confirms that safety targets have been achieved.

Some specific elements of Enbridge's Integrity Management Program include:

Corrosion prevention system: This system is designed to prevent or minimize corrosion of the pipeline steel. While the pipe coating is the primary barrier between the environment and the steel, cathodic protection (CP) systems impress a small electrical current to Enbridge's pipelines to suppress corrosion activity from occurring. The CP system applied to Enbridge's pipelines is similar to corrosion prevention systems applied to other infrastructure such as bridges, buildings and ships. Enbridge routinely monitors protection levels in accordance with regulations to ensure performance and compliance with applicable regulations. The CP and coating systems are complementary in the prevention of corrosion, and provide redundancy in the overall corrosion prevention system.

Monitoring: The mainstay of Enbridge's monitoring program relies on in-line inspection (ILI) technology to assess the condition of the pipeline. Enbridge regularly inspects all segments of Line 5 with multiple high-resolution technologies, including:

- **Geometry caliper:** Mechanical arms that measure the internal diameter of the pipeline to monitor for pipeline deformation such as dents and wrinkles.
- **Inertial mapping:** Three-dimensional guidance systems that measure the position of the pipeline to support bending-strain analysis and detection of pipeline movement.
- **Magnetic flux leakage:** Sensors that detect distortion in an induced magnetic field to detect metal loss within the pipe wall and identify corrosion or other defects such as gouging.
- **Ultrasonic corrosion:** Ultrasonic sensors that measure thickness of the steel to detect metal loss within the pipe wall and identify corrosion or other defects such as gouging.
- **Ultrasonic crack:** Ultrasonic sensors that detect discontinuities in the steel to identify crack-like features.

ILI technologies are supported by other monitoring techniques that rely on external sensors attached to the pipeline to monitor localized changes in pipeline condition, such as movement, pipeline strain or corrosion rates.

Results of Enbridge's inspections are integrated into the company's data management systems to facilitate assessment of the condition of its pipelines, monitor for any changes, and identify mitigation requirements. Enbridge typically repeats monitoring programs every three to five years, and accordingly, the company has numerous data sets obtained over the past few decades that are integrated into the assessment to identify trends and changes over time.

Assessment: Results from Enbridge's ILI programs are integrated with pipeline data acquired through physical inspections, operational data and right-of-way (ROW) data, including the location of high-consequence areas and geohazards on the ROW. Enbridge uses the integrated data to conduct detailed assessments to confirm the current fitness for service of a pipeline, i.e. that the pipeline meets design requirements and remains strong, and to forecast the pipeline's future condition. Through these assessments, Enbridge identifies where mitigation activities are required to maintain pipeline safety and fit-for-purpose operational capacity and to satisfy regulatory or Enbridge criteria.

Mitigation: Enbridge's mitigation programs typically include field repair where the pipeline is excavated and repaired at identified locations to re-establish or maintain required safety factors. The programs also may include a temporary reduction in pipeline operating pressure

to maintain required safety factors until such time as field repairs are completed. During field repair, Enbridge collects non-destructive evaluation (NDE) data to document the pipeline condition, prior to repair. NDE data are generated by various direct-examination techniques conducted by technicians in the field to measure pipeline defects. The technologies used are similar to ILI technologies, such as physical measurements and magnetic and ultrasonic inspections. The NDE data are very important as they provide a means to verify the accuracy of the ILI data and validate the assessment and mitigation program. The NDE data are further used to support reliability and statistical analysis and verify overall program performance and future maintenance-planning activities.

For reference, a summary of the key components of Enbridge's Integrity Management Program for Line 5 is publicly available in the Consent Decree entered into by Enbridge and the U.S. federal government in 2017. (https://www.epa.gov/enforcement/enbridge-entered-consent-decree).

Geohazard Management Program

Enbridge has an established and mature Geohazard Management Program, which covers more than 7,000 locations across Enbridge's Liquids Pipelines (LP) system in Canada and the U.S., including water crossings and slopes. Contrary to the design of the Line 5 Straits pipeline crossing, water crossings on the remaining segments of Line 5 were designed and constructed to be buried below ground. The program follows a structure similar to the Mainline System integrity program described above, including planning, monitoring, assessment and mitigation activities. In consultation with third-party consultant SMEs, Enbridge has developed criteria for establishing regular monitoring schedules for each crossing based on the likelihood of ROW conditions changing with time.

Monitoring is conducted by geohazard consultants who are experts in watercourse management (hydrotechnical) and earth movements (geotechnical). Routine inspections are completed at intervals ranging from annually for water-crossing sites with higher potential to be impacted by environmental changes, or multiple years for sites that are less likely to be impacted by environmental changes that may, for example, result in exposure of the pipelines.

Enbridge also monitors geohazards through established routine aerial patrol conducted at three week, or less, intervals. Enbridge's Operations personnel conduct additional inspections in response to weather events, such as flooding, that could have caused a change in conditions at a location. Pilots and Enbridge regional Operations personnel are trained to identify changes in site conditions and identify potential threats to a pipeline. These inspections are documented and reviewed by geohazard specialists to identify any follow-up actions required.

Improvements in monitoring, assessment and mitigation have continued to be a primary focus for Enbridge, with the program progressing from post-weather-event monitoring to developing techniques for monitoring weather events such as flooding or landslides in real time. In 2015, Enbridge incorporated real-time flood monitoring of its pipeline system at water crossings. The monitoring system is operated by third-party consultant engineers, whereby established criteria initiate notification of Enbridge personnel at various flood stages. Criteria were established through engineering analyses at each crossing and are based on pipeline parameters, crossing details and flood levels.

Further improvements are ongoing today, with Enbridge's research and development activities focused on developing monitoring enhancements utilizing advanced satellite techniques, in-water 3D sonar imaging and direct-scour-detection installations that can further improve not only Enbridge's but also the pipeline industry's ability to manage geohazard threats.

Through Enbridge's existing monitoring activities, water crossings that are showing signs of deterioration in pipeline cover or where pipelines have become exposed are prioritized for assessment to evaluate additional mitigation activity, such as increased monitoring frequency or restoration of soil cover above the pipeline.

Damage Prevention Program

The goal of Enbridge's Damage Prevention Program is to anticipate, prevent, manage and mitigate damage to company assets in order to ensure the safety of people, property and the environment. The main components of the program are:

- **Public awareness**, which is designed to deliver continual education to affected internal and external stakeholders about the Enbridge pipeline system (please see below for more details).
- **Land use and ownership monitoring**, which is designed to monitor land use and ownership on an ongoing basis on land in which an Enbridge pipeline is located, as well as the adjacent land.
- **Pipeline locates**, which are designed to respond to information requests from individuals or companies on location information of Enbridge's underground pipeline systems in the form of ground-surface markings and location documentation (e.g. drawings). This includes but is not limited to established One-Call Centers, such as Michigan's MISS DIG utility safety notification system.
- **Surveillance and monitoring**, which is designed to monitor the condition of Enbridge's pipelines and facilities through both regularly scheduled inspections and ad-hoc surveillance activities. It includes but is not limited to: regular aerial- and ground-based ROW monitoring, depth-of-pipeline-cover monitoring, pipeline markers, ROW crossing inspections, in-line inspections, soil-to-pipe surveys, construction and operation inspections, pressure testing, purchased-material inspections, class-location surveys, erosion monitoring, and slope-stability monitoring.
- **Ground disturbance**, which is designed to establish requirements for planning and conducting ground-disturbance activities at all Enbridge locations to ensure safe excavation on or near the company's pipeline system.
- **Third-party monitoring**, which is designed to ensure that safety is maintained during third-party activity over or adjacent to Enbridge rights-of-way by requiring preapproval and field inspection during ground disturbance activities.

Some key aspects of the damage prevention program include:

- **Right-of-way monitoring:** This is designed to proactively monitor and detect potentially damaging activities occurring on or near Enbridge's pipeline system. This includes but is not limited to: aerial and/or ground patrols; identifying and mitigating areas of insufficient depth by pipeline-depth surveys; confirming pipeline markers are in place and in good condition; and inspection performed as per executed agreement or regulatory requirements.
- **Public Awareness Program:** Through this program, Enbridge disseminates information to the public and employees about: the location of the company's pipeline system; how to detect a leak; how to live and work near pipelines; how to report any contact, damage or unauthorized activity; how to use the services of MissDig or 811; and how to recognize and report potential leaks and emergencies.
- **Pipe Depth-of-Cover Program:** This company-wide program aims to periodically assess depth of cover of Enbridge's pipelines using a risk-based approach for all pipelines. Through this program, Enbridge prioritizes areas of high consequence and standardizes methods of mitigation for damage prevention. When an area of concern is identified, the program initiates actions to maintain safety and ensure adequate depth of cover for the identified section of pipeline.

Mitigation Programs Focused on Consequence Reduction

Enbridge's entire pipeline network is monitored 24/7/365 by a dedicated team of specially trained Enbridge staff members at the company's Pipeline Control Center. These controllers undergo a comprehensive six- to nine-month training program before they are qualified to operate consoles independently.

All system alarms generated by Enbridge's automated leak detection equipment, and relayed to our control-center staff, are assumed to be leaks until they are conclusively proven otherwise.

Leak Detection Program

Enbridge is committed to employing industry-leading leak detection methodologies. This is achieved by meeting or exceeding all applicable engineering standards and regulatory requirements, and by employing skilled personnel and the most suitable technologies.

Enbridge is also committed to continuous improvement of its leak detection strategy, which is a comprehensive, multi-layered approach for its pipeline network. The strategy encompasses several leak-monitoring methods, each with a different focus and featuring differing technology, resources and timing. Used together, these methods provide an overlapping and comprehensive leak detection capability. These methods include:

Controller monitoring: Enbridge's Pipeline Controller monitors pipeline conditions (such as pipeline pressure) through the Supervisory Control And Data Acquisition ("SCADA") system, which is designed to identify unexpected operational changes, such as pressure drops, that may indicate a leak. Additional sensors monitored through SCADA such as concentrations of explosive vapor, pump seal failures, equipment vibration levels and sump levels can also be used by the controller to identify potential leaks at facility locations.

Computational pipeline monitoring (CPM): Enbridge employs computer-based pipeline monitoring systems that utilize measurements and pipeline data to detect and alarm on anomalies that could indicate possible leaks. The primary method of leak detection is the computational pipeline monitoring (CPM) system, which provides a sophisticated computer real-time transient model (RTTM) that simulates the hydraulic state of Enbridge's pipelines in real time, including transient conditions. The system continuously monitors changes in calculated volume of liquids to alert the controller and leak-detection analyst of potential leak conditions.

Scheduled line balance calculations: Enbridge utilizes pipeline volume balance calculations within its commodity movement tracking and volume balance CPM systems. These calculations are commonly referred to as "over/short reports" and are calculations of oil inventory performed at fixed intervals. The purpose of these calculations is to identify unexpected losses of pipeline inventory that may indicate a possible leak.

Rupture detection: Enbridge employs a complementary CPM system that measures pump-station pressure and flow in order to identify and alarm on pipeline rupture events. Upon receipt of a rupture alarm, control-center procedures require immediate shutdown of the pipeline.

Automated pressure deviation (APD): Enbridge employs a complementary CPM system that utilizes pressure measurements during pipeline shut-in conditions and generates an alarm if a significant or abnormal pressure drop occurs.

Automated volume balance (AVB): Enbridge employs a complementary CPM method that determines time-averaged volume imbalances. If an imbalance exceeds a pre-set threshold, it will generate an alarm.

Acoustic in-line inspection: To complement its Leak Detection Program, Enbridge uses, on an as-needed basis, acoustic in-line inspection tools on prioritized pipeline segments such as the Straits crossing. These tools are specially designed to confirm the integrity of the pipeline and detect and pinpoint the location of small leaks by "listening" for unique acoustic signatures.

Volume Balance and Negative Pressure Wave System (hybrid system): Enbridge is currently in the process of operationalizing this CPM technology into our procedures. The system uses high-speed pressure transmitters to assist a statistical compensated flow balance system in detecting leaks faster and pinpointing the location.

Enbridge regularly measures the performance of its leak detection systems through leak-detection tests, such as simulated leaks or fluid-withdrawal tests. Enbridge also measures performance to confirm system reliability and sensitivity targets are achieved and to evaluate the overall effectiveness of technology, people and processes.

Isolation Valve Placement

Isolation valves are used to control or halt the flow of crude oil and other liquids, and represent a key piece of safety equipment on a pipeline system.

Through its Intelligent Valve Placement (IVP) methodology, Enbridge applies risk assessment and engineering practices to ensure valves are placed at the right, optimal location to reduce the potential release volume. *Figure 2* illustrates at a high level the stages of the valve placement analysis.

While valves do not prevent a release from occurring, they can reduce the consequences of a release to people and the environment. Consequently, the IVP program is another important element in Enbridge's multi-layered approach to safety, which includes robust pipeline maintenance, in-line inspections, leak detection, 24/7/365 system monitoring and comprehensive emergency management programs.

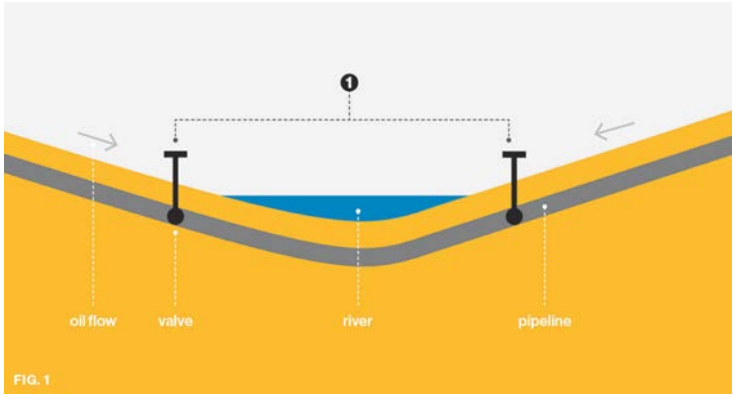
The IVP program considers only the placement of remotely controlled valves, as they can be closed by staff at Enbridge's Pipeline Control Center immediately upon detection of a problem, with full closure occurring within three minutes of activation. Determining the optimal location of these valves can be influenced by a number of factors, including topography, the presence of water crossings and high-consequence areas—such as urban population centers, drinking-water resources, environmentally sensitive areas and commercially navigable waterways. The IVP program optimizes valve locations along the pipeline so that one valve can protect multiple water courses and/or high-consequence areas.

Figure 2: Summary of Intelligent Valve Placement (IVP) process.

Step 1: Analysis
Iterative analysis considering regulations, water bodies, population centers and other sensitive areas, volume and topography.
Step 2: Tentative Valve List
The iterative analysis produces a tentative valve list.
Step 3: Engineering Evaluation
The placement undergoes an engineering evaluation of the analysis.
Step 4: Optimal Valve List
The resulting list is the optimal list.
Step 5: Field Verification
The optimal list undergoes field verification to ensure placement is possible; further analysis may be required.
Step 6: Final Valve List
The list of valves that can be built to provide the greatest volume reduction across the line and at sensitive locations.

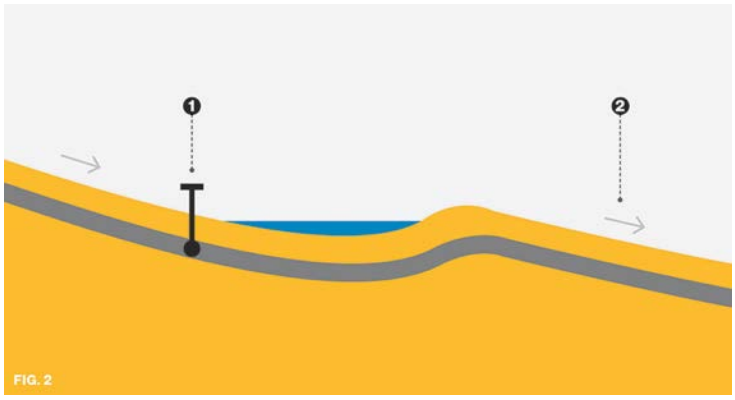
The primary consideration for valve placement is reducing the potential flow of oil to lower elevations, particularly those in close proximity to major water crossings and high-consequence areas. Enbridge's IVP program protects those water crossings and high-consequence areas by taking advantage of gravity, using high points of topography to provide natural isolation of product between valves. The following illustrations are examples of the principles Enbridge follows to determine the optimal placement of valves when considering the topography of an area.

Double-sided valley



Oil flows downhill in a pipeline after the system is shut down. In a valley scenario as depicted, Enbridge installs an isolation valve on each side of the water body (1). The specific valve locations, including distance from the water body, are optimized through the IVP methodology.

Single-sided valley

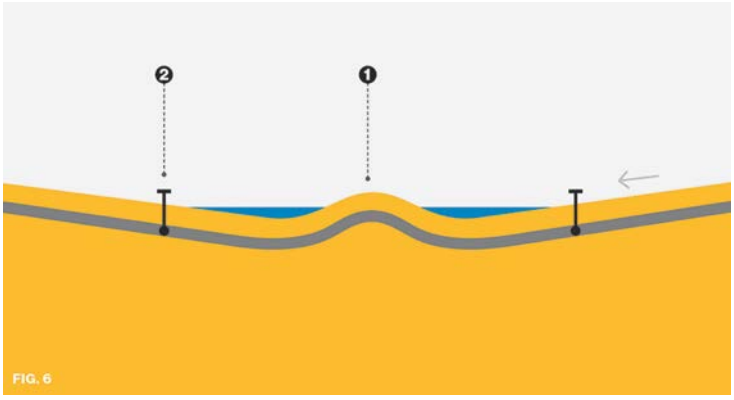


Oil flows downhill in a pipeline after the system is shut down. In this scenario, an isolation valve is placed on the left side of the body of water (1). However, on the right side of the body of water (2), oil would drain downhill away from the body of water, and a valve would provide no isolation benefit.

Long valley

In some cases, isolation valves are not directly adjacent to the banks of major water crossings. Instead, they are intentionally placed to protect not only major water crossings, but also high-consequence areas (3) such as additional watercourses, water intakes, urban infrastructure and ecologically sensitive areas.

Long valley with multiple crossings



For a long valley with multiple water crossings, the land between the crossings acts as a high point, providing natural isolation from crossing to crossing (1). Optimal valve location at left is near the bottom of the long, sloping valley (2); in effect, this placement allows one valve to protect more than one water crossing.

Line 5 Isolation Valve Placement

In recent years, valve placement on Line 5 through Michigan has undergone thorough review through Enbridge's IVP process and by independent third parties. As a result, 30 remotely controlled valves on Line 5 in Michigan have been added or been converted from manual to remote operation. Following the completion of construction of five valves that are currently under construction in 2018, there will be 60 remotely controlled valves and additional manual valves on Line 5 in Michigan. This program has further been reviewed in depth and validated through activities required by the Consent Decree.

Line 5 Emergency Response Plan

Enbridge maintains an Integrated Contingency Plan for the Great Lakes Region, which includes all of Line 5 in Michigan. This plan is a comprehensive, all-hazards response plan that includes: notification procedures; environmental and community considerations; available internal and external resources; and response guidelines for various incident scenarios. Enbridge conducts an annual review of this plan to ensure it provides the most up-to-date information.

Since 2010, and continuing over the last few years, Enbridge has worked to increase the amount of dedicated emergency response equipment in Michigan. Along Line 5, there are approximately 28,000 feet of containment boom, 15 skimmers, nine boats, eight current busters, three ice-slotting trailers and two bucket-recovery systems. This equipment can be used in a wide range of water conditions—from a small creek, to the Great Lakes. Enbridge maintains this emergency response equipment at eight locations along Line 5.

Enbridge has agreements in place with three oil-spill-response organizations (OSROs) that have resources strategically placed near Enbridge operations and could respond quickly during an incident. These OSROs can provide additional response capabilities in the form of vacuum trucks, containment boom, boats and skimmers. Along Line 5, there are six OSRO emergency-response trailers, and additional equipment is staged near Detroit. In addition to OSROs, Enbridge has identified other contractors that can assist in the event of an incident; they include heavy equipment operators, wildlife response experts, environmental contractors and more.

Emergency response training at Enbridge is robust and focused on key response roles. Field-response team members take 52 hours of training in boat handling, inland-oil-spill response and cold-weather-oil-spill response. This training is then followed up with 40 hours of recertification courses every three years. In the Great Lakes Region, more than 75 field-response team members have been trained on boom-deployment techniques. Incident-management team members are required to take 24 hours of basic Incident Command System (ICS)* training (ICS 100-300) and eight to 16 hours of position-specific training. In the Great Lakes Region, more than 50 incident-management team members have completed this training.

In addition to training, Enbridge conducts a variety of exercises to test the field-response teams, incident-management teams and emergency response plans. At a minimum, the Great Lakes Region is required to conduct quarterly Qualified Individual notifications, annual incident-management team table-top exercises, annual equipment-deployment exercises and triennial full-scale exercises. The Great Lakes Region goes above and beyond this requirement; since 2015, it has completed 38 field-equipment deployments, 33 table-top exercises and two full-scale exercises.

Environmental Management

Enbridge uses environmental-sensitivity maps to prepare emergency response plans to ensure the appropriate personnel and equipment are deployed to these sites. Information sources for these maps include publicly available data sites supported by federal, State and local resources. Enbridge also utilizes this data to locate and prioritize environmentally sensitive sites during project planning and permitting and to protect these sites during construction, ongoing pipeline operation and maintenance.

The data used to prepare the sensitivity maps also assist in the development of baseline assessments, which are used during site-restoration efforts after construction or emergency response activities.

* ICS is a common approach to managing incident response used across North America by military, first response agencies, and local, State Technical Team, provincial and federal governments.

Line 5 Water Crossings Consequence Evaluation and Prioritization

As established in the plan for this water-crossings initiative, a detailed assessment was completed to identify high-consequence areas based on local State of Michigan environment and population sensitivities. This assessment supplemented established regulatory and industry best practices, augmenting the current process of delineating high-consequence areas based on criteria established in the Code of Federal Regulations, CFR195 Transportation of Hazardous Liquids by Pipeline.

Initially, Enbridge and the State Technical Team reviewed all locations listed in the U.S. Geological Survey's 1:24,000-scale National Hydrography Dataset (NHD)*. This review considered close to 400 surface water crossings, including wetlands, along Line 5 in Michigan.

To facilitate a more in-depth assessment of priority water crossings, the State Technical Team developed a consequence model to develop a relative ranking of all crossings. The process was reviewed by the State Technical Team and Enbridge SME team, and relative components were validated against existing Enbridge models (i.e. spill-plume modelling). The output of the prioritization was further reviewed and finalized by both Enbridge and the State Technical Team and used to identify potential supplemental action items.

State Technical Team Consequence Evaluation and Prioritization

In light of the wealth and diversity of natural resources found along Line 5's route through Michigan, the State Technical Team conducted a comprehensive accounting and review of the pipeline's water crossings, beginning with the pipeline entry point into Michigan at the Wisconsin border and ending at the Ontario border.

With the help of the State Technical Team's SMEs and the best available geospatial data, the State Technical Team identified nearly 400 sites where Line 5 crosses a waterbody in Michigan.

The State Technical Team then conducted a preliminary review of these water-crossing sites to ensure data accuracy and identify key natural resources located in the vicinity of the pipeline.

Building on this initial evaluation, the State Technical Team conducted a second-level review to systematically identify crossings at which a potential oil release from Line 5 is likely to result in disproportionately higher levels of damage to the residents of Michigan and/or to the environment. To complete this step, the State Technical Team assessed the following characteristics that, in general, would serve to markedly impact the overall consequences and costs of a potential release:

- Downstream distance to a Great Lake or other large waterbody.
- Whether the crossing is located within a Coastal Management Zone.
- Whether the crossed waterbody is a State-designated Natural River.
- Flow velocity of the crossed waterbody.

* The NHD is a digital geospatial dataset that maps the surface water of the United States. Specifically, the NHD represents the nation's drainage networks and related features, including rivers, streams, canals, lakes, ponds, glaciers, coastlines, dams, and streamgages. The NHD High Resolution, at 1:24,000 scale or better, is the most up-to-date and detailed hydrography dataset for the nation. (Source: U.S. Geological Survey)

- Whether critical or imperiled wetlands are located along the crossed waterbody.
- The quantity and sensitivity of threatened or endangered species along and downstream of the crossing.
- Whether the crossing is located within a Wellhead Protection Area.
- The downstream distance to surface drinking-water intakes.
- The population density near and downstream of the crossing.

The State Technical Team evaluated each of the nearly 400 crossings within the context of these factors. Resources located closer to Line 5, where the potential impact is greater, were rated higher than those located further downstream. A summary of the State Technical Team consequence evaluation, including the crossings of highest concern, was provided to Enbridge for further evaluation.

Additional Prioritization Based on Enbridge's Geohazard Program

Enbridge's geohazard program includes water crossings that meet the criteria of perennial flow, i.e. where water is present 12 months a year and there is sufficient flow to potentially present a hazard to the pipeline. The State Technical Team consequence prioritization included crossings that have intermittent presence of water, also known as ephemeral streams; in essence, where a release from the pipeline could pose a hazard to the stream.

To identify additional potential prioritized water crossings, Enbridge reviewed the water crossings included in its existing Geohazard Management Program to compare them with the result of the State Technical Team prioritization. The results of the comparison identified several sites included in the State Technical Team prioritization that did not meet the criteria for inclusion in the Enbridge Geohazard Management Program. Accordingly, establishing a baseline condition assessment at these locations was identified as a proposed action, described further in the *Action Plan* section of this Report. The review also identified several crossings that are included as part of Enbridge's Geohazard Management Program, but were not included in the State Technical Team prioritization, and were considered a priority for additional assessment by Enbridge based on known site conditions, or absence of data. These locations were also added to the prioritized crossings.

Summary of Prioritized Crossings

Based on the Enbridge and State Technical Team review, a total of 74 water crossings were prioritized. These included 67 water-crossing sites identified by the State Technical Team consequence prioritization, and an additional seven sites identified by Enbridge's geohazard program review.

Once the prioritization process was completed, the 74 crossings were reviewed collectively by Enbridge and the State Technical Team to establish boundaries around general regions of highest consequence. These areas were termed "groupings". The start and end point of each grouping was established by extending the area 500 feet upstream and 500 feet downstream of the crossings at either end of the grouping. In cases where only one water crossing was included in a grouping, the area was established based on 500 feet upstream and downstream of that crossing. A total of 11 groupings were established through this process.

A summary of the 74 individual crossings and related groupings is presented in *Tables 1 and 2*, respectively, in *Appendix A*.

Assessment of Mitigation Measures

Enbridge conducted a detailed review of the application of existing mitigation programs for each individual prioritized crossing, as well as for the areas delineated into groupings.

The following provides a high-level overview of Enbridge's review and a description and timeline for resulting proposed actions.

Tables 1 and 2 in *Appendix A* provide a summary of the allocation of actions to the crossings and groupings.

Action Items Focused on Likelihood (Leak Prevention)

Mainline Pipeline Integrity

First, Enbridge conducted a high-level review to confirm that safety targets have been met and maintained on all segments of Line 5 within Michigan. Then, Enbridge conducted a detailed reliability assessment at each individual prioritized crossing to evaluate the probability of failure (POF) based on crack, corrosion and dent threats to the pipeline.

The results of the detailed quantitative reliability assessment demonstrated a very high level of safety at all locations. POF assessment for crack and corrosion threats are fully quantitative processes, whereas POF assessment for dent threats are semi-quantitative. Accordingly, it was determined that additional detailed reliability assessment for dents may be helpful to further quantify levels of safety.

Proposed Actions Related to Enbridge's Mainline Integrity Program

- **Increase safety targets within grouping areas** by 10 times compared to current safety targets. (6 months)
- **Complete further detailed dent reliability assessment** to further quantify levels of safety for dent features located within grouping areas. (12 months)

Geohazard Management

Based on a detailed review of its Geohazard Management Program, Enbridge developed proposed actions for crossings historically included in the program, as well as additional crossings identified through the prioritization process.

Enbridge identified the actions through a detailed review of program data. For example, existing depth-of-cover data was compared to the predicted impacts of a one-in-500-year flood event in order to estimate the potential for pipeline exposure.

Enbridge's geohazard program includes the management of slopes, so the company conducted a detailed review of slopes located at the prioritized crossing locations and the grouping areas. There were no slopes identified where actions would be required to augment existing management plans.

Proposed Actions Related to Enbridge's Geohazard Management Program

- **Field data collection:** Collect additional field data and further assess where (a) data are obsolete or absent and, therefore, conservative assumptions are in place; and (b) where known shallow depth of cover or exposed pipe exists. (18 months)
- **Conduct engineering assessment:** An engineering assessment of a water crossing involves completing a specific scope of work that includes detailing the risk of multiple threats in a quantitative manner, as well as detailing various mitigation options. For Line 5 water crossings, the scope of work would include a hydrotechnical assessment for vortex-induced vibration susceptibility, debris-loading susceptibility, and hydrodynamic loading and associated stress analysis of the pipeline. In addition, the potential for hydrological changes in the watercourse will be assessed, including channel migration, degradation and scouring. If the engineering assessment identifies that remediation is required, Enbridge will assess various remediation options including: additional or augmented monitoring; pipeline lowering; pipe-crossing replacement through either horizontal directional drilling (HDD) or watercourse remediation, including bank/bed armoring. (18 months)
- **Baseline geohazard assessment:** Carried out by a geohazard consultant, this involves both a desktop and field survey of a water crossing. The assessment identifies both the physical size and shape of the crossing, as well as the attributes of the crossing that determine susceptibility to change, i.e. channel width, channel slope/gradient, channel depth, evidence of migration, sinuosity, bed material type, and bank shape and composition. Based on this assessment, the geohazard consultant will determine if the water-crossing site should be added to the inventory of geohazard sites to be monitored routinely or if the site should be listed as an inactive site that does not require routine monitoring. (18 months)
- **Depth of cover (DoC)/bathymetric survey:** A bathymetric survey provides a detailed surface/elevation profile of the bottom of a watercourse both upstream and downstream of the pipeline crossing and overlays the pipeline elevation/shape to get a snapshot of the DoC of the pipeline, as well as any properties near the crossing that can affect the cover over the pipeline during high-flow conditions. These types of surveys require a specialized sonar sensor that scans the watercourse bottom from a boat, and requires a minimum depth of water and size of crossing in order to be able to collect useful data.

  For very shallow or small crossings, a DoC survey is completed by comparing the pipe elevation to individual sonar beam readings to determine what the watercourse cover is directly over the pipeline. Rather than a three-dimensional shape of the watercourse, a simplified two-dimensional shape of the watercourse bottom is produced, with the pipeline elevation profile shown. (18 months)
- **Perform a detailed scour study:** Existing properties of a water crossing are used to determine how much pipe cover can be lost during extreme flooding events—for example, a one-in-100-year flood event. If the potential loss of cover due to scour exceeds the current depth of cover, then an additional assessment is completed to determine any threat to the pipeline during extreme flooding events. (18 months)
- **Replacement/lowering:** This involves remediation of a water crossing by replacing the pipe at the crossing with a new drilled crossing. Currently, two replacement/lowering projects are in development: the St. Clair River; and the North Branch Mill Creek. If additional locations are recommended for replacement/lowering based on the results of engineering assessments, Enbridge would prioritize the locations and schedule the work as soon as practicable in consideration of permitting requirements and seasonal constraints.

Damage Prevention

As described in the *Overview of Enbridge's Existing Mitigation Programs* section of this Report, Enbridge applies its Damage Prevention Program broadly across its entire North American pipeline system.

Through discussions with the State Technical Team, the following high-level opportunities for improvement were identified to augment existing practices in Michigan.

Proposed Actions Related to Damage Prevention

- **Public outreach to the Michigan Association of County Drain Commissioners:** Due to the scope of the Drainage Commissioners' responsibilities, there is opportunity to explore additional outreach opportunities. (6 months)

Consequence-reduction Action Items

Leak Detection

Based on the technologies and practices employed for leak detection as part of Enbridge's Leak Detection Program—and their application across the entire length of the company's North American pipeline system, including Line 5—at this time no additional actions were identified.

Isolation Valve Placement

Based on a thorough review of the existing number and location of isolation valves, as well as the planned installation of additional valves as required by the Consent Decree, no additional actions were identified relative to the prioritized crossing and grouping locations.

Emergency Response (ER)

A significant focus of Enbridge's Emergency Response Program is training and public awareness. Enbridge conducts regular internal training exercises and engages with first responders and other agencies to participate in education and training exercises.

Through discussions, two opportunities for improvement were identified.

Proposed Actions Related to Emergency Response

- **Review ER training and exercise communication plan:** There is an opportunity to improve communication with the State Technical Team to enhance awareness and potential for increased participation. Enbridge will provide to the State Technical Team an annual schedule of upcoming Michigan exercises and ICS training events. (6 months)
- **Establish additional emergency response tactical control points:** Tactical control points are predetermined locations from which release protection, containment and/or recovery operations may be conducted with the expectation of a high degree of success.

  Enbridge currently maintains 255 tactical control points for significant water crossings along Line 5. These control points are currently undergoing field verification and will be updated by the end of 2018.

  When compared to the priority water crossings identified by the Enbridge/State Technical Team, it was determined that 89 percent of the crossings have existing control points.

  The team reviewed the locations where additional control points could also be established at 14 to 17 water crossings, enhancing existing plans, including: Cass River; Chicagon Slough; Fishdam River; Fraser Garfield Drain Branch; Frenchfarm Lake; Kitchen Creek; Little Sturgeon River; Moran River; Mud Creek; North Branch Ogontz River; Pointe aux Chenes River; and Rapid River. (12 months)
- **Collaborative review of ER tactical control points:** Enbridge will work with the State to schedule a working session to develop a process to review and discuss environmental sensitivities associated with its tactical control point plans along Line 5. (9 months)

Environmental Management

Enbridge's current process for establishing baseline Environmental Sensitivity Maps is focused mainly at the federal level.

Through team discussions, it was determined that utilizing Michigan-specific species and habitat data to supplement current data sources would better inform Enbridge's environmental-related programs, i.e. baseline assessments, engineering projects, operations and maintenance planning, and emergency response planning with respect to permitting and environmental sensitivities.

Current and comprehensive data on locations of species and population status are essential to constructing useful Inland Sensitivity Atlases for construction planning, release planning and response, and to understand potential and actual resource injury. Without such data, 'absence of evidence' is often incorrectly assumed to be 'evidence of absence', and as a result, both species and sensitive habitats may be impacted inadvertently. For example, without an understanding of rare wetland-habitat locations, it is possible that these wetlands could be unintentionally damaged by heavy equipment during release response; whereas with an understanding of rare wetland habitat locations, alternatives could be considered to minimize or avoid impacts to these wetlands.

The goal of the baseline data development project would be to perform surveys of aquatic and riparian species and plant communities upstream and downstream of select Line 5 pipeline water crossings in Michigan. The State Technical Team and Enbridge reviewed existing records and determined where data was either lacking or no longer reliable. They then prioritized the data gaps and developed recommended survey approaches to address those gaps. Depending on the data gaps and the location of the water crossing, implementation of the surveys may require teams that specialize in plant species and rare wetland communities, fish, freshwater mussels, and other benthic invertebrates, which are organisms that live in or on the bottom sediments of rivers, streams, and lakes.

The following paragraphs describe the various baseline survey needs and how information should be collected.

Proposed Actions Related to Environmental Management

- **Conduct baseline environmental studies (rare wetland communities):** Conducting quantitative species surveys across several taxon groups is very labor intensive and time consuming. In lieu of species surveys, it was determined that the most valuable information to consider and maintain is the location and condition of Michigan's highest ecologically valued wetlands. Having information on high-quality sensitive habitat can assist with prioritizing placement of deterrents to assist in recovery efforts. The Michigan DNR (MDNR) and DEQ (MDEQ) place great value on the State's rare wetland communities and they would be one of the highest priorities to protect and restore in a recovery effort.

  The team conducted a review of known wetland natural communities in the State's Natural Heritage Database. All element occurrences (EOs)* were reviewed to determine their last survey date. Those EOs whose most recent survey data were 10 years or older from 2019, are represented by Water Crossing Group (see *Table 2* in *Appendix A*). One additional water-crossing site was added due to concerns that the pipeline may be negatively affecting the quality of the site. It was recommended that these sites should be re-inventoried and mapped using the standard protocol/data form that the Michigan Natural Features Inventory uses and be submitted to the State for inclusion in the Natural Heritage Database.

  A summary of the locations selected for conducting baseline environmental studies is included in *Appendix B*. (18 months)

* An element occurrence is an area of land and/or water in which a species or ecological community is, or was, present.

- **Conduct biology mitigation study:** Fisheries and mussel surveys and biological integrity assessments will establish baseline data on water quality and biologic health of a waterbody. These are described below, and the surveys/assessments are listed by water crossing in *Table 1* in *Appendix A*. (18 months)
  - **Fisheries:** Surveys are routinely conducted in Michigan's streams using the MDNR's Status and Trends protocol (please see http://www.michigandnr.com/PUBLICATIONS/pdfs/IFR/manual/SMII_Chapter26.pdf). The Stream Status and Trends Program uses standardized sampling protocols, as well as both a network of fixed sites and a stratified random sampling design, to address questions at the most relevant spatial and temporal scales. The team reviewed information from the MDNR Fisheries Division's Fish Collection System database to determine if there were priority water crossings where there were either data gaps or existing data was outdated, e.g. >15 years old. The team identified 12 water-crossing sites where fisheries data needs to be collected using Michigan's Stream Status and Trends protocol.
  - **Freshwater mussels:** Michigan has recently published Michigan Freshwater Mussel Survey Protocols and Relocation Procedures (https://www.fws.gov/midwest/EastLansing/te/pdf/MIFreshwaterMusselSurveyProtocolsRelocationProceduresFeb2018.pdf). Of Michigan's 43 mussel species, 19 have special conservation status as either threatened or endangered at the state or federal level and 12 more are identified as being of special concern at the state level. It is well known that freshwater mussels are an important component of the biodiversity of Michigan's aquatic ecosystems. Information predicting the occurrence of rare and sensitive mussel species was included in an online Geographic Information System (GIS) viewer and compared against all Line 5 water crossings to help the team determine where there were either data gaps or existing data were outdated, e.g., >15 years old. The team identified 31 water-crossing sites where freshwater-mussel data needs to be collected using Michigan's Freshwater Mussel Survey Protocols, and 12 of these sites overlap with locations where fish data is needed.
  - **Biological integrity:** Biological integrity assessments are routinely conducted using the MDEQ Surface Water Assessment Section Procedure 51 (see https://www.michigan.gov/deq/0,4561,7-135-3313_3681_3686_3728-32369--,00.html). Procedure 51 (P51) is a rapid method for collecting qualitative biological and habitat information. A P51 data layer was included in an online GIS viewer and this information helped the team determine where there were either data gaps or existing data was outdated (e.g. >15 years old). The team identified 11 water-crossing sites where biological integrity data needs to be collected using P51, although several of these identified sites may have useable data collected under protocols for non-wadeable rivers. Enbridge and the MDEQ will work to confirm whether relevant data already exists for the identified sites.
- **Update environmental sensitivity maps with State sensitivity data:** Incorporation of State priority water crossing data from existing sources for all crossings, as well as new survey data collected, will help inform environmental considerations for programs such as construction planning, emergency response, invasive species management and restoration. (12 months)
- **Review Emergency Response Aquatic Invasive Species Inspection Procedure:** Coordinate a review of the Enbridge Emergency Response Aquatic Invasive Species Inspection and Certification Form with the State Technical Team to identify opportunities for incorporating potential additional localized sensitivities. (12 months)

Further to the action items proposed above, a commitment to continuous improvement is desirable. Accordingly, the proposed actions would be managed in an adaptive style, allowing for the ability to modify protocols based on survey results and with the support of both Enbridge and the State Technical Team.

Action Plan

This Report summarizes the conclusions reached through Enbridge's and the State Technical Team's collaborative process to:

- Identify and assess all Line 5 water crossings in Michigan.
- Prioritize water crossings identified with higher potential consequence due to potential of loss of containment of the pipeline.
- Assess the effectiveness of current mitigation programs to prevent and minimize consequences in the event of a pipeline leak.
- Identify proposed actions to further reduce risk.

The work focused on a thorough review and discussion, including both prevention- and consequence-mitigation processes.

The proposed actions described in the *Assessment of Actions* section of this Report are summarized below. The application of each action to specific locations is further documented in *Appendix A* and *Appendix B*. The proposed actions include those that would be implemented under the accountability of Enbridge, as well as actions that would be implemented jointly by the State Technical Team and Enbridge, with Enbridge acting as a sponsoring partner.

Actions to Be Implemented by Enbridge

The following actions would be implemented under the direct accountability and control of Enbridge.

- **Increase Safety Targets Within Grouping Areas** (6 months)
- **Complete Dent Reliability Assessment** (12 months)
- **Conduct Engineering Assessment** (18 months)
- **Baseline Geohazard Assessment** (18 months)
- **DOC/Bathymetric Survey** (18 months)
- **Perform Detailed Scour Study** (18 months)
- **Replacement/Lowering** (schedule to be determined)
- **Michigan Association of County Drain Commissioners Public Outreach** (6 months)
- **Review ER Training and Exercise Communication Plan** (6 months)
- **Establish Additional ER Tactical Control Points** (12 months)
- **Collaborate Review of ER Tactical Control Points** (9 months)
- **Update Environmental Sensitivity Maps with State Sensitivity Data** (12 months)
- **Review Emergency Response Aquatic Invasive Species Inspection Procedure** (12 months)

Actions to Be Implemented Jointly by the State Technical Team and Enbridge

The following actions would be completed jointly by the State Technical Team, with Enbridge providing sponsorship funding and partnering with the State to ensure the measures meet State expectations. All assessments would be targeted for completion within 18 months of commencing.

- **Conduct Baseline Environmental Studies (Rare Wetland Communities)**
- **Conduct Biology Mitigation Study**
  - Fisheries
  - Freshwater Mussels
  - Biological Integrity

Appendix A:
Summary of Prioritized Water Crossings and Groupings

Table 1: Summary of Individual Prioritized Water Crossings and Action Items

Grouping Name	Crossing Name	MilePost	Increased Safety Targets	Engineering Assessment	Baseline Geohazard Assessment	DOC/Bathymetric Survey	Detailed Scour Study	Replacement/ Lowering	Drain Comm. Public Outreach	Establish ER Tactical Control Points	ER Training & Exercise Comm. Plan	Collaborative Review of Tactical Control Points	Review ER Aquatic Species Insp Proc.	Update Env Sensitivity Maps	Bio. Mitig. Study Fisheries	Bio. Mitig. Study Mussels	Bio. Mitig. Study—Bio. Integrity	Notes
Lake Gogebic	Pelton River	1222.5	✓						✓		✓	✓	✓	✓				
Lake Gogebic	Slate River	1223.79	✓						✓		✓	✓	✓	✓				
Watersmeet	Duck Creek	1244.39	✓			✓			✓		✓	✓	✓	✓				
Iron River to Crystal Falls	Sunset Creek	1273.13	✓			✓	✓		✓		✓	✓	✓	✓			✓	
Iron River to Crystal Falls	Chicagon Slough	1280.08	✓			✓			✓	✓	✓	✓	✓	✓				2-3 preliminary ER control points proposed
Iron River to Crystal Falls	Waterworks Creek	1289.06	✓						✓		✓	✓	✓	✓		✓		
Iron River to Crystal Falls	Paint River	1290.2	✓						✓		✓	✓	✓	✓		✓		
Iron River to Crystal Falls	Tributary to Paint River	1292.128	✓	✓					✓		✓	✓	✓	✓				
Iron River to Crystal Falls	Michigamme River	1294.77	✓						✓		✓	✓	✓	✓		✓	✓	
Iron River to Crystal Falls	East Branch Sturgeon River	1309.19	✓						✓		✓	✓	✓	✓		✓	✓	
Iron River to Crystal Falls	Ford River	1315.63	✓						✓		✓	✓	✓	✓		✓		
Iron River to Crystal Falls	North Branch Ford River	1322.91	✓						✓		✓	✓	✓	✓		✓		
Rapid River to Manistique	Rapid River	1356.88	✓			✓	✓		✓	✓	✓	✓	✓	✓		✓		Scour assessment required if DOC <2'
Rapid River to Manistique	Whitefish River	1358.16	✓			✓	✓		✓		✓	✓	✓	✓				
Rapid River to Manistique	North Branch Ogontz River	1365.94	✓						✓	✓	✓	✓	✓	✓				1-2 preliminary ER control points proposed
Rapid River to Manistique	Sturgeon River	1369.87	✓						✓		✓	✓	✓	✓				
Rapid River to Manistique	Fishdam River	1377.54	✓				✓		✓	✓	✓	✓	✓	✓				1-2 preliminary ER control points proposed

Grouping Name	Crossing Name	MilePost	Increased Safety Targets	Engineering Assessment	Baseline Geohazard Assessment	DOC/Bathymetric Survey	Detailed Scour Study	Replacement/ Lowering	Drain Comm. Public Outreach	Establish ER Tactical Control Points	ER Training & Exercise Comm. Plan	Collaborative Review of Tactical Control Points	Review ER Aquatic Species Insp Proc.	Update Env Sensitivity Maps	Bio. Mitig. Study Fisheries	Bio. Mitig. Study Mussels	Bio. Mitig. Study—Bio. Integrity	Notes
Rapid River to Manistique	Dufour Creek (1)	1386.22	✓			✓			✓		✓	✓	✓	✓				
Rapid River to Manistique	Dufour Creek (2)	1387.71	✓						✓		✓	✓	✓	✓				
Rapid River to Manistique	Indian River	1393.58	✓						✓		✓	✓	✓	✓		✓		
Rapid River to Manistique	Manistique River	1394.33	✓			✓			✓		✓	✓	✓	✓				
Rapid River to Manistique	Merwin Creek	1402.25	✓			✓			✓		✓	✓	✓	✓				
Rock River to the Straits	Unnamed	1426.50	✓		✓	✓			✓		✓	✓	✓	✓				
Rock River to the Straits	Rock River	1426.54	✓			✓			✓		✓	✓	✓	✓	✓	✓		
Rock River to the Straits	Lower Millecoquins River	1433.93	✓			✓	✓		✓		✓	✓	✓	✓	✓	✓		Scour assessment required if DOC <2’
Rock River to the Straits	Black River	1439.35	✓						✓		✓	✓	✓	✓				
Rock River to the Straits	Tributary to Black River	1440.09	✓						✓		✓	✓	✓	✓				
Rock River to the Straits	Borgstrom Creek	1441.17	✓						✓		✓	✓	✓	✓				
Rock River to the Straits	East Branch Black River	1442.05	✓						✓		✓	✓	✓	✓	✓	✓		
Rock River to the Straits	Davenport Creek	1444.57	✓						✓		✓	✓	✓	✓				
Rock River to the Straits	Cut River	1452.56	✓						✓		✓	✓	✓	✓	✓	✓		
Rock River to the Straits	Unnamed	1456.49	✓		✓				✓		✓	✓	✓	✓				
Rock River to the Straits	Unnamed	1456.83	✓		✓				✓		✓	✓	✓	✓				

Grouping Name	Crossing Name	MilePost	Increased Safety Targets	Engineering Assessment	Baseline Geohazard Assessment	DOC/Bathymetric Survey	Detailed Scour Study	Replacement/ Lowering	Drain Comm. Public Outreach	Establish ER Tactical Control Points	ER Training & Exercise Comm. Plan	Collaborative Review of Tactical Control Points	Review ER Aquatic Species Insp Proc.	Update Env Sensitivity Maps	Bio. Mitig. Study Fisheries	Bio. Mitig. Study Mussels	Bio. Mitig. Study—Bio. Integrity	Notes
Rock River to the Straits	Unnamed	1457.28	✓		✓				✓		✓	✓	✓	✓				
Rock River to the Straits	Brevoort River	1464.43	✓						✓		✓	✓	✓	✓	✓	✓		
Rock River to the Straits	Pointe aux Chenes River (2)	1466.49	✓						✓	✓	✓	✓	✓	✓				1 preliminary ER control point proposed
Rock River to the Straits	Pointe aux Chenes River (3)	1466.64	✓				✓		✓		✓	✓	✓	✓	✓	✓	✓	
Rock River to the Straits	Tributary to Kitchens Creek	1469.67	✓			✓			✓	✓	✓	✓	✓	✓			✓	2 preliminary ER control points proposed
Rock River to the Straits	Moran River	1472.77	✓			✓			✓	✓	✓	✓	✓	✓				1 preliminary ER control point proposed
Mackinaw to Indian River	Frenchfarm Lake	1481.69	✓		✓				✓	✓	✓	✓	✓	✓				1 preliminary ER control point proposed
Mackinaw to Indian River	Mud Creek	1488	✓			✓			✓		✓	✓	✓	✓		✓		1 preliminary ER control point proposed
Mackinaw to Indian River	Tributary to Douglas Lake	1495.41	✓			✓			✓		✓	✓	✓	✓		✓		
Mackinaw to Indian River	Unnamed	1499.91	✓		✓				✓		✓	✓	✓	✓				
Mackinaw to Indian River	Indian River	1507.76	✓						✓		✓	✓	✓	✓	✓	✓	✓	
Mackinaw to Indian River	Little Sturgeon River (2)	1508.71	✓			✓			✓		✓	✓	✓	✓		✓		2 preliminary ER control points proposed
Mackinaw to Indian River	Little Sturgeon River (1)	1510.58	✓			✓			✓		✓	✓	✓	✓				
Au Sable Watershed	Au Sable River	1561.98	✓						✓		✓	✓	✓	✓	✓	✓	✓	
Au Sable Watershed	Red Creek	1563.36	✓						✓		✓	✓	✓	✓	✓	✓	✓	
Au Sable Watershed	West Branch Big Creek (2)	1565.73	✓			✓			✓		✓	✓	✓	✓				

Grouping Name	Crossing Name	MilePost	Increased Safety Targets	Engineering Assessment	Baseline Geohazard Assessment	DOC/Bathymetric Survey	Detailed Scour Study	Replacement/ Lowering	Drain Comm. Public Outreach	Establish ER Tactical Control Points	ER Training & Exercise Comm. Plan	Collaborative Review of Tactical Control Points	Review ER Aquatic Species Insp Proc.	Update Env Sensitivity Maps	Bio. Mitig. Study Fisheries	Bio. Mitig. Study Mussels	Bio. Mitig. Study—Bio. Integrity	Notes
Au Sable Watershed	West Branch Rifle River	1591.73	✓						✓		✓	✓	✓	✓		✓		
Saginaw Bay	Walk Drain	1619.99	✓			✓			✓		✓	✓	✓	✓				
Saginaw Bay	Pinconning River	1621.4	✓						✓		✓	✓	✓	✓	✓	✓	✓	
Saginaw Bay	Fraser Garfield Drain	1625.99	✓			✓			✓	✓	✓	✓	✓	✓				4 preliminary ER control points proposed
Saginaw Bay	North Branch Kawkawlin River	1631.59	✓			✓			✓		✓	✓	✓	✓	✓	✓		
Saginaw Bay	Hembling Drain	1633.81	✓			✓			✓		✓	✓	✓	✓				
Saginaw Bay	Kawkawlin River	1637.94	✓			✓	✓		✓		✓	✓	✓	✓				Scour assessment required if DOC <2'
Saginaw Bay	Squaconning Creek	1642.77	✓						✓		✓	✓	✓	✓				
Saginaw Bay	Unnamed	1643.59	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Unnamed	1643.89	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Unnamed	1644.36	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Saginaw River	1645.11	✓			✓			✓		✓	✓	✓	✓	✓	✓	✓	
Saginaw Bay	Unnamed	1646.84	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Unnamed	1647.1	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Unnamed	1647.1	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Unnamed	1648.17	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Unnamed	1648.67	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Unnamed	1650.18	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Unnamed	1651.07	✓		✓				✓		✓	✓	✓	✓				
Saginaw Bay	Quanicasse River	1654.74	✓			✓			✓		✓	✓	✓	✓				
Vassar	Moore Drain	1667.31	✓			✓			✓		✓	✓	✓	✓				
Vassar	Cass River	1668.51	✓			✓			✓	✓	✓	✓	✓	✓		✓		2 preliminary ER control points proposed
Vassar	Squaw Creek Drain	1682.81	✓						✓		✓	✓	✓	✓		✓		

Grouping Name	Crossing Name	MilePost	Increased Safety Targets	Engineering Assessment	Baseline Geohazard Assessment	DOC/Bathymetric Survey	Detailed Scour Study	Replacement/ Lowering	Drain Comm. Public Outreach	Establish ER Tactical Control Points	ER Training & Exercise Comm. Plan	Collaborative Review of Tactical Control Points	Review ER Aquatic Species Insp Proc.	Update Env Sensitivity Maps	Bio. Mitig. Study Fisheries	Bio. Mitig. Study Mussels	Bio. Mitig. Study—Bio. Integrity	Notes
Vassar	Indian Creek	1687.36	✓						✓		✓	✓	✓	✓		✓		
North Branch Mill Creek	North Branch Mill Creek	1706.57	✓					✓	✓		✓	✓	✓	✓		✓		
St. Clair	Pine River	1724.74, 1725.92, 1276.48, 1727.06, 1727.35, 1728.75	✓						✓		✓	✓	✓	✓		✓		
St. Clair	Pine River (3)	1728.36	✓			✓			✓		✓	✓	✓	✓		✓		
St. Clair	Pine River (2)	1728.52	✓			✓			✓		✓	✓	✓	✓		✓		
St. Clair	Cuttle Creek (1)	1732.47	✓			✓			✓		✓	✓	✓	✓				
St. Clair	Cuttle Creek (1)	1732.72	✓			✓			✓		✓	✓	✓	✓				
St. Clair	Unnamed	1733	✓		✓				✓		✓	✓	✓	✓				
St. Clair	St. Clair River (Line 5)	1735.23	✓					✓	✓		✓	✓	✓	✓			✓	

Table 2: Summary of Grouping Areas and Action Items

Grouping Name	Number of Prioritized Crossings	Increased Safety Targets	Dent Reliability Assessment	Detailed Engineering Assessment	Drain Comm. Public Outreach	ER Training & Exercise Comm. Plan	Update Env Sensitivity Maps	Notes
St. Clair	6	✓			✓	✓	✓	
Vassar	2	✓			✓	✓	✓	
Saginaw Bay	19	✓			✓	✓	✓	
Au Sable watershed	3	✓			✓	✓	✓	
Mackinaw to Indian River	7	✓	✓		✓	✓	✓	
Iron River to Crystal Falls	6	✓	✓		✓	✓	✓	
Rapid River to Manistique	10	✓	✓		✓	✓	✓	
Watersmeet	1	✓			✓	✓	✓	
Rock River to the Straits of Mackinac	17	✓	✓	✓	✓	✓	✓	Detailed engineering assessment for scour and debris loading susceptibility on exposed pipe
Lake Gogebic	2	✓			✓	✓	✓	
North Branch Mill Creek	1	✓			✓	✓	✓	

Appendix B:
Summary of Proposed Baseline Environmental Studies per Grouping (Rare Wetland Communities)

St. Clair River Crossing Group

Natural Community Type	MNFI Element Occurrence ID	Last Survey Date	Acres	Notes	Mile Marker
Great Lakes Marsh	6708	1988	526	D rank; may not need survey	Downstream (in the Lake) from 1735.23

Saginaw Bay Water Crossings Group

Natural Community Type	MNFI Element Occurrence ID	Last Survey Date	Acres	Notes	Mile Marker
Great Lakes Marsh	11243 Coryeon Point	1988	~1500		In Saginaw Bay connected to 1658.03-1650.18
Great Lakes Marsh	3956 Pinconning Marsh	1988	185		1621.84-1618.06
Great Lakes Marsh	7139 Saganing River Delta	1988	60	CD rank	1621.84-1619.99
Great Lakes Marsh	3574 Pine River Delta	1988	553		1614.88-1607.33

Straits of Mackinac to Rock River Water Crossings Group

Natural Community Type	MNFI Element Occurrence ID	Last Survey Date	Acres	Notes	Mile Marker
Great Lakes Marsh	8215 Point St. Ignace	1986	55		No mile marker; immediately east of bridge
Limestone Cobble Shore	12061 Gros Cap	1985	28		1472.77-1469.66
Wooded Dune and Swale Complex	5042 Pointe Aux Chenes	1987	5023	USFS RNA Pipeline runs through EO	1469.66-1466.64
Wooded Dune and Swale Complex	1975 Brevort Lake and Dunes	1986	1456	CD rank Pipeline runs through EO	1464.43-1457.28
Wooded Dune and Swale Complex	562 West Epoufette	2007	202	Paquin Creek empties here	1448.22-1446.08

Manistique to Rapid River Water Crossings Group

Natural Community Type	MNFI Element Occurrence ID	Last Survey Date	Acres	Notes	Mile Marker
Wooded Dune and Swale Complex	986 Thompson	2012	6524	C; Pipeline runs through EO	1398.58-1387.71
Wooded Dune and Swale Complex	11401 Big Bay De Noc	2007	3955	High-quality fen within swales; Fishdam River flows through. USFS	1380.70-1373.89
Patterned Fen	17177 Moss Lake	2009	536	USFS	1373.83-1369.87
Floodplain Forest	6203 Sturgeon River	1989	394	USFS	1369.87
Rich Conifer Swamp	17322 Nahma	2009	481	USFS	1369.83-1365.94
Poor Fen	17321 Nahma	2009	429	USFS	1369.83-1365.94
Wooded Dune and Swale Complex	2 Ogontz Bay	1992	2284	USFS; Ogontz river flows through	1365.94
Great Lakes Marsh	200 Whitefish River Delta, Rapid River	1987	384	USFS; Whitefish River flows through EO	1358.16-1356.88

In addition to surveys of the above known element occurrences, surveying will also be conducted for new occurrences in some limited portions of the priority water crossing groups that have a high potential for rare wetlands. These are data gaps where Michigan has some of the highest quality natural resources that would be at risk in the event of a release.

Straits of Mackinac to Rock River Water Crossing Group

Survey Area	Notes	Mile Marker
Shoreline South Portage Road to Brevort Lake	Under surveyed shoreline; multiple Great Lakes Endemic species; exposed limestone at surface.	1472.77 to 1464.43

Indian River to Straits of Mackinac Water Crossing Group

Survey Area	Notes	Mile Marker
Wetlands on the east side of French Farm Lake	This is the only site added to the priority crossing list; wetland quality unknown though multiple rare species hits within lake and adjacent to Lake Michigan Shoreline. Direct route to Lake Michigan.	1481.69

Appendix C:
Abbreviations, Acronyms and Definitions

APD	automated pressure deviation
AVB	automated volume balance
CFR	Code of Federal Regulations
CPM	Computational Pipeline Monitoring system
CSA	Canadian Standards Association
DoC	depth of cover
EO	element occurrence
EPA	U.S. Environmental Protection Agency
ER	emergency response
GIS	Geographic Information System
HCA	high-consequence area
HDD	horizontal directional drilling
ILI	in-line inspection
IVP	intelligent valve placement
LP	Enbridge's Liquids Pipelines business segment
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
NHD	National Hydrography Dataset
NDE	non-destructive evaluation
OSRO	oil-spill-response organizations
P51	The MDEQ's Surface Water Assessment Section Procedure 51, a rapid method for collecting qualitative biological and habitat information
PHMSA	Pipeline and Hazardous Materials Safety Administration
POF	probability of failure
RNA	Research Natural Area: areas that the USFS has designated to be permanently protected and maintained in natural condition
ROW	right-of-way
RTTM	real-time transient model
SCADA	Supervisory Control and Data Acquisition
SME	subject-matter expert
USFS	U.S. Forest Service

200, 425 – 1st Street S. W.
Calgary, Alberta, Canada T2P 3L8

Telephone: 403-231-3900
Facsimile: 403-231-3920
Toll free: 800-481-2804

enbridge.com